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## PATENT

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Date: October 6, 2000ASSISTANT COMMISSIONER FOR PATENTS  
WASHINGTON, D.C. 20231  
BOX NEW PATENT APPLICATIONJC925 U.S. PTO  
09/684150  
10/06/00

Sir:

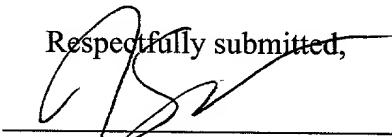
Transmitted herewith for filing is the patent application of  
Inventor(s): **Evangelos A. Yfantis**

For: Method and Apparatus for Determining the Size and Shape of a Foot

Enclosed are:

(X) Specification in 21 pages;  
(X) 10 sheet(s) of drawing;  
(X) A Declaration and Power of Attorney by inventor in 2 pages;  
(X) A Verified Statement Claiming Small Entity Status in 2 pages;  
(X) Return prepaid postcard; and  
(X) A check in the amount of \$355 for fees calculated as set forth below:

CLAIMS AS FILED				
FOR	NUMBER FILED	NUMBER EXTRA	RATE	FEE
Basic Fee			\$710	\$710
Total Claims	18 - 20 =	0 ×	\$18	\$0
Independent Claims	3 - 3 =	0 ×	\$78	\$0
If application contains any multiple dependent claims(s), then add			\$260	\$0
			TOTAL	\$710
			REDUCTION BY ½ FOR FILING BY A SMALL ENTITY	\$355
			<b>TOTAL FILING FEE</b>	<b>\$355</b>

Dated: October 6, 2000By: 

Respectfully submitted,

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**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY  
STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR**

Docket No.  
**YFANTIS.0008P**

Serial No.  
**Unknown**

Filing Date  
**Herewith**

Patent No.

Issue Date

Applicant/ **Evangelos A. Yfantis**  
Patentee:

Invention: **METHOD AND APPARATUS FOR DETERMINING THE SIZE AND SHAPE OF A FOOT**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- the specification to be filed herewith.
- the application identified above.
- the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Evangelos A. Yfantis

SIGNATURE OF INVENTOR 

DATE: OCT. 6, 2000

NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

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NAME OF INVENTOR \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

**CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)**

Applicant(s): Evangelos A. Yfantis

Docket No.

YFANTIS.0008P

Serial No.  
UnknownFiling Date  
Herewith

Examiner

Group Art Unit

Invention: **METHOD AND APPARATUS FOR DETERMINING THE SIZE AND SHAPE OF A FOOT**JC925 U.S. PTO  
09/684150  
10/06/00

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**Verified Statement Claiming Small Entity Status in 2 pages***(Identify type of correspondence)*

is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under  
37 CFR 1.10 in an envelope addressed to: The Assistant Commissioner for Patents, Washington, D.C. 20231

October 6, 2000*(Date)***R. Scott Weide***(Typed or Printed Name of Person Mailing Correspondence)**(Signature of Person Mailing Correspondence)***EE802269450US***("Express Mail" Mailing Label Number)***Note: Each paper must have its own certificate of mailing.**

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Applicant(s): Evangelos A. Yfantis

Docket No.

YFANTIS.0008P

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Group Art Unit

Invention: **METHOD AND APPARATUS FOR DETERMINING THE SIZE AND SHAPE OF A FOOT**JCS  
09/684150 PTO

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Examiner

Group Art Unit

Invention: **METHOD AND APPARATUS FOR DETERMINING THE SIZE AND SHAPE OF A FOOT**JC925 U.S. PTO  
09/684150  
10/06/00

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**CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)**

Applicant(s): Evangelos A. Yfantis

Docket No.

**YFANTIS.0008P**Serial No.  
UnknownFiling Date  
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Examiner

Group Art Unit

Invention: **METHOD AND APPARATUS FOR DETERMINING THE SIZE AND SHAPE OF A FOOT**JC925 U.S. PTO  
09/68410  
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37 CFR 1.10 in an envelope addressed to: The Assistant Commissioner for Patents, Washington, D.C. 20231October 6, 2000*(Date)***R. Scott Weide***(Typed or Printed Name of Person Mailing Correspondence)**(Signature of Person Mailing Correspondence)***EE802269450US***("Express Mail" Mailing Label Number)***Note: Each paper must have its own certificate of mailing.**

**CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)**

Applicant(s): Evangelos A. Yfantis

Docket No.

YFANTIS.0008P

Serial No.  
UnknownFiling Date  
Herewith

Examiner

Group Art Unit

Invention: **METHOD AND APPARATUS FOR DETERMINING THE SIZE AND SHAPE OF A FOOT**JC925 U.S.P.T.O.  
09/684151  
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UNITED STATES PATENT APPLICATION

FOR

**METHOD AND APPARATUS FOR DETERMINING THE SIZE  
AND SHAPE OF A FOOT**

PREPARED BY:

WEIDE & ASSOCIATES, LTD.  
330 S. 3rd St. Suite 1130  
Las Vegas, NV 89101  
(702)-382-4804

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for obtaining the size and shape of a foot from a scan of an imprint of the foot for use in manufacturing orthotic shoes and sandals and orthotic inserts to a shoe.

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BACKGROUND OF THE INVENTION

In many instances, it is necessary to provide an orthotic/orthopedic shoe insert, or a shoe, sandal or other footwear which is customized to meet a particular wearer's needs. For example, in some instances it is necessary to provide an insert which compensates for differences in the lengths of the legs of a human.

It is desirable for the footwear, such as the shoe itself or an insert for the shoe, to accurately mate with the wearer's foot. The two feet of a wearer may be different from one another, however, and both feet of one person may vary substantially from the feet of another person. Therefore, the shape, including the width, length, depth and curvature of one or both of the feet of the person must be accurately determined for use in preparing the shoe or insert.

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Current methods for determining the size and shape of the foot are imprecise and slow. For example, the size of the foot may be measured with a mechanical measuring device, and the shape estimated using templates. The error introduced in these methods often renders the orthotic or shoe unsatisfactory. In addition, this foot size and shape data is difficult to utilize when manufacturing the orthotic.

SUMMARY OF THE INVENTION

The present invention generally comprises a method and apparatus for determining the shape and dimensions of a human foot. One embodiment of the invention comprises a method of determining the shape and size of a foot comprising the steps of obtaining an imprint of the foot, 5 scanning the imprint of the foot to obtain pixel image data regarding the foot imprint at one or more points, determining at said one or more points the depth of the imprint from the pixel image data, and determining a size of said foot from the pixel image data.

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In one embodiment, the step of obtaining an imprint of the foot comprises the step of a person stepping onto a foam member and compressing a portion of the foam member. In one embodiment, an imprint may be created of both feet of a person.

In one embodiment, the step of scanning the imprint generates RGB (red, green, blue) pixel image data. The RGB data is converted to YIQ image data. The depth of the imprint at a point is determined from the luminance or Y value of the pixel data for a point.

In one embodiment, the depth is calculated as a linear function of the Y value and a slope of the Y value at that point. In this calculation, coefficients are used to accurately determine the depth value. In one embodiment, the coefficients are determined using a method of least squares to minimize the average error. In another embodiment, the coefficients may be determined by physically measuring the depth of the imprint and calculating the coefficient values from the known data.

In one or more embodiments, foot size information is determined from the image data. In one embodiment, an original scan image of the imprint is passed through a filter. The filtered image is utilized to generate an enhanced original image. The edge and sharp transition areas of the imprint, and thus the foot, are enhanced in this image. The visually enhanced edge areas aid in defining the start and/or end points for distance or “size” measurements.

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In accordance with the invention, the curvature of one or more areas of the foot may be determined. In one embodiment, the curvature of the arch is determined.

In accordance with the invention, the size and shape of a foot may be determined from an image scan of an imprint of the foot. The size and shape data may be used to create an orthotic, shoe or other member which mates accurately with the foot. In one embodiment, the information may be transmitted, compressed and transmitted, stored or the like. For example, the foot size and shape data may be stored for comparison against later data so that changes in the size and shape of a person's foot may be determined.

Further objects, features, and advantages of the present invention over the prior art will become apparent from the detailed description of the drawings which follows, when considered with the attached figures.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a flow diagram illustrating a method of scanning a foot in accordance with the present invention;

5                   Figure 2 illustrates hardware for use in a method of the present invention;

Figure 3 illustrates a scanned image of a foam imprint of left foot;

Figure 4 illustrates a scanned image of a foam imprint of a right foot;

10                  Figure 5 illustrates a grid used for measuring a foam imprint of a foot;

Figure 6 illustrates the grid illustrated in Figure 5 used to sample the depth of a foam imprint;

15                  Figure 7 is a topographical display and graph of toes of a foot generated utilizing information obtained in accordance with a method of the invention;

Figure 8 is a topographical display and graph of an arch of a foot generated utilizing information obtained in accordance with a method of the invention;

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Figure 9 is an open GL 3D-Display of an image of a foot generated utilizing information obtained in accordance with a method of the invention; and

Figure 10 is a 3-D image of a foot generated utilizing information obtained in accordance with a method of the invention, the image rotated and zoomed from that illustrated in Figure 9.

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DETAILED DESCRIPTION OF THE INVENTION

The invention is a method and apparatus for determining the size and shape of a foot. In the following description, numerous specific details are set forth in order to provide a more thorough description of the present invention. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without these specific details. In other instances, well-known features have not been described in detail so as not to obscure the invention.

One embodiment of the invention comprises a method for determining the size and shape of a human foot based on an imprint of the foot. A method of the present invention will be described with reference first to Figure 1. In a step S1, an element for retaining a physical representation of a foot is provided. In one or more embodiments, the element for retaining the physical representation comprises a foam member. Such a foam member 20 is illustrated in Figure 2.

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In an embodiment where an imprint of a foot is to be created, the foam member 20 is selected to be larger than the size of the foot which is to create the imprint. It will be appreciated that in one embodiment, a foam member 20 is provided for each foot for which an imprint is desired, i.e., in the case of both feet, one for the right foot and the other for the left foot. The foam member 20 is preferably of a greater width and length than the foot which is to provide the imprint. In addition, the foam member 20 is preferably of sufficient depth to retain an imprint which is as deep as the foot being imprinted.

DRAFTING SHEET NO. 5

Each foam member 20 is arranged to retain, with exacting geometric accuracy, the imprint of the foot of the person. Thus, when the person steps down on a top surface of the foam member 20, the foam member is arranged to compress in those areas where the user's foot makes contact. The remaining portions of the foam member 20 are preferably not deformed during the imprinting, 5 and once the imprint is made, the foam member preferably retains the imprint. In other words, the foam member 20 must be sufficiently compressible to permit creation of the imprint, and not be resilient in a manner which would result in destruction of the imprint after its formation. Such foam members 20 are known and currently available, such as from the company Foot Levelers, Inc. It is contemplated that the foot imprint may be created and retained with other materials, such as with 10 plasters and the like.

In the preferred embodiment of the invention, the method and apparatus is directed to determining the dimensions and shape of a foot. It will be appreciated that the method and apparatus may be utilized to provide shape and size information of other parts of the body, such as a hand, or even inanimate objects.

In a step S2 of the method, the person steps on the foam member to generate an imprint of the foot in the foam member. Of course, in an embodiment where the shape of something other than a foot is to be physically retained, then that element is pressed into the foam member. For example, 20 the shape of a hand may be retained by pressing the hand into a foam member.

In a step S3, each of the foam imprints is scanned via a scanner connected to a computer to generate an imprint image. In one embodiment the scanner comprises an optical scanner. In one

or more embodiments, the scanner is modified so that the foam imprints are retained in a fixed position and the scanner is arranged to move relative thereto. In another embodiment, the scanner may be fixed and the foot imprint moved relative thereto. The scanner is arranged to scan the imprint of the foot in the foam member and provide red-blue-green (RGB) image scan data. In general, this step comprises the scanner representing areas of the foam imprint with a plurality of individual pixels, each pixel represented by RGB data. In one embodiment, an origin is selected for the pixels and the pixels are arranged into k-columns and m-rows. In one embodiment, the origin for the pixels is chosen to be located at the top-left corner of the foam element 20. Each pixel then has an associated coordinate (k,m), with the origin pixel having coordinates (0,0). Figures 3 and 4 illustrate scans of foam imprints of a right foot and left foot of a person.

In a preferred embodiment, the RGB data representing the scanned images of the foam imprints of the feet are transmitted to a computer or other processing device. In one embodiment, the scanned image information is transferred to a computer to which the scanner is connected via an interconnecting communication cable.

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Figure 2 illustrates hardware which may be utilized to accomplish the scanning process. As illustrated, the hardware may include an optical scanner 22. In a preferred embodiment, a communication link is provided between the scanner 22 and a computer 24. As illustrated, this link 20 comprises a cable 26. Of course, the link may be wired or wireless and follow any of a variety of protocols/architectures, such as serial/parallel.

In a step S4, the RGB data is converted to YIQ data, where Y represents the luminance and I and Q are the chrominance components corresponding to each pixel. A variety of methods and apparatus are well known to those of skill in the art for accomplishing this conversion. As such, this step will not be described in detail herein.

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In a step S5, the depth of the imprint is determined using the pixel image data. In one embodiment, the portion of the top surface of the foam member which is undisturbed is considered to have a zero depth, and the depth of the footprint is measured relative to the undisturbed surface.

10 For an arbitrary pixel with coordinates (k, m), the depth  $d_{km}$  of the imprint may be represented as a linear function of the luminance  $Y_{km}$ , and the absolute slope of the luminance  $S_{km}$ . Thus:

$$d_{km} = aY_{km} + bS_{km} + c + \varepsilon_{km}$$

This function may be re-represented as:

$$\varepsilon_{km} = d_{km} - aY_{km} - bS_{km} - c$$

or

$$\sum_{k=1}^h \sum_{m=1}^v \varepsilon_{km}^2 = \sum_{k=1}^h \sum_{m=1}^v (d_{km} - aY_{km} - bS_{km} - c)^2$$

In one embodiment, a method of least squares is employed to estimate the parameters a, b, c. Therefore, in the function:

$$f(a, b, c) = \sum_{k=1}^h \sum_{m=1}^v (d_{km} - aY_{km} - bS_{km} - c)^2$$

it is necessary to estimate the coefficients (a, b, c) which minimize the function. In one embodiment, this step comprises computing the partial derivatives with respect to a, b, c, setting them to zero and solving the system with respect to a, b, c.

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$$\frac{\partial f(a, b, c)}{\partial a} = -2 \sum_{k=1}^h \sum_{m=1}^v (d_{km} - aY_{km}^2 - bS_{km}Y_{km} - cY_{km}) = 0$$

$$\frac{\partial f(a, b, c)}{\partial b} = -2 \sum_{k=1}^h \sum_{m=1}^v (d_{km}S_{km} - aY_{km}S_{km} - bS_{km}^2 - cS_{km}) = 0$$

$$\frac{\partial f(a, b, c)}{\partial c} = -2 \sum_{k=1}^h \sum_{m=1}^v (d_{km} - aY_{km} - bS_{km} - c) = 0$$

This last function can be written as

$$10 \quad \bar{d} = a\bar{Y} + b\bar{S} + c$$

or

$$c = \bar{d} - a\bar{Y} - b\bar{S}$$

From the above it will be seen that:

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$$a = \frac{\sum_{k=1}^h \sum_{m=1}^v (d_{km} - \bar{d})(Y_{km} - \bar{Y}) \sum_{k=1}^h \sum_{m=1}^v (S_{km} - \bar{S})^2 - \sum_{k=1}^h \sum_{m=1}^v (S_{km} - \bar{S})(Y_{km} - \bar{Y}) \sum_{k=1}^h \sum_{m=1}^v (S_{km} - \bar{S})(d_{km} - \bar{d})}{\sum_{k=1}^h \sum_{m=1}^v (Y_{km} - \bar{Y})^2 \sum_{k=1}^h \sum_{m=1}^v (S_{km} - \bar{S})^2 - \sum_{k=1}^h \sum_{m=1}^v ((S_{km} - \bar{S})(Y_{km} - \bar{Y}))^2}$$

$$b = \frac{\sum_{k=1}^h \sum_{m=1}^v (Y_{km} - \bar{Y})^2 \sum_{k=1}^h \sum_{m=1}^v (S_{km} - \bar{S})(d_{km} - \bar{d}) - \sum_{k=1}^h \sum_{m=1}^v (d_{km} - \bar{d})(Y_{km} - \bar{Y}) \sum_{k=1}^h \sum_{m=1}^v (S_{km} - \bar{S})(Y_{km} - \bar{Y})}{\sum_{k=1}^h \sum_{m=1}^v (Y_{km} - \bar{Y})^2 \sum_{k=1}^h \sum_{m=1}^v (S_{km} - \bar{S})^2 - \sum_{k=1}^h \sum_{m=1}^v ((S_{km} - \bar{S})(Y_{km} - \bar{Y}))^2}$$

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In one or more embodiments, the values  $d_{km}$   $k=1,\dots,h$ , and  $m=1,\dots,v$ , comprising the horizontal and vertical coordinates respectively, the values of  $h$ , comprising the horizontal resolution in number of pixels, and the values of  $v$ , comprising the vertical resolution in number of pixels, are measured directly from the foam imprints of feet. In one embodiment, a grid 30 is used in this process. Referring to Figure 5 there is illustrated such a grid 30. In one embodiment, the grid 30 comprises a generally rectangular frame having a plurality of elements defining horizontal and vertical positions. These elements may comprise wires or filaments extending between opposing portions of the frame. These elements define a grid of points and the intersections of these elements, each intersection point having (x, y) coordinates. In one embodiment, the elements are placed

approximately .25 inches apart, such that each intersection point along a row or column is about .25 inches apart.

As illustrated in Figure 6, the grid 30 may be superimposed on the foam imprint of the foot.

5 Next, the depth of the imprint at each of the intersection points may be determined. Furthermore, the luminance  $Y$  may be measured at each intersection point, and then the slope of the luminance  $S$  determined therefrom. Using the above formulas, this physically obtained data may be used to determine the values of the coefficients (a, b, c). Variations in the density and color of the foam pads and other noise/error introducing factors may change the values of the coefficients (a, b, c).  
10 It has been found, however, that the values (a, b, c) remain relatively constant across differing imprints made with like foam pads. In order to reduce any variance and increase the stability of the estimates, in one embodiment, a plurality of random foam imprints may be used to estimate the values of (a, b, c), with the values for each imprint averaged out and the average values used in the formula  $d_{km} = aY_{km} + bS_{km} + c$ .

15 In a step S6, an enhanced original image is generated for use in determining the size of the

foot. In this step, it is desirable to generate an enhanced image of the foot imprint which permits easy measurement of the distances between edge or sharp transition areas of the various portions of the foot, such as the outer edge of the foot at the heel and the toes, and the intersection area of the  
20 toes with the foot.

In one embodiment, a filter is utilized to emphasize the data representing the scanned foot imprint. In one embodiment, the pixel image data is passed through a low pass filter. This results

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in a filtered image which generally emphasizes the interior portions (i.e. non-edge areas) of the foot imprint. Next, the data (i.e. values) representing the filtered image are subtracted from the original image. In this step, a new altered image is generated which emphasizes the edge areas of the foot imprint. Lastly, an enhanced original image is created by adding the altered image data to the original image data. This generates an original image having the edge areas thereof visually enhanced. Such an image is illustrated in Figures 9 and 10.

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In a step S7, data is obtained regarding other dimensions of the foot, such as the length and width of the foot. In one embodiment, this information is obtained from the enhanced original image of the foot. A variety of data may be obtained. In one embodiment, a distance from each toe end to the end of the heel of the foot is determined. In one or more embodiments, the distance from the phalanges from the left base corner of the large toe and the right base of the small toe is also obtained.

In a step S8, the curvature of the arch of the foot is determined. In one embodiment, the curvature is determined from the depth data, which permits calculation of the rate of change in the depth of the foot imprint (and thus the foot). In one embodiment, the depth information at points corresponding to the arch area of the foot imprint are utilized to obtain the curvature of the arch at various points there along.

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In a step S9, an orthotic insert, shoe, sandal or a variety of other items may be created for exact mating with the foot of the person. For example, the foot shape and size data can be used to generate a mold for an orthotic insert or can be provided to a computer-controlled manufacturing

device for machining such an insert. This data can be transmitted over a communication network from a location where the imprint was obtained to a remote manufacturer. For example, the imprint may be obtained at a doctor's office, and then the information transmitted to a manufacturer in another city for use in producing an insert. In one embodiment, the foot shape and size data may 5 be compressed using a lossless compression algorithm to improve the speed and reliability of the data transfer.

In one or more embodiments, the image of the imprint and size and shape data may be displayed or printed. It will also be appreciated that a variety of the steps above may be accomplished with hardware or software. For example, the RGB to YIQ conversion may be 10 accomplished with appropriate software.

In one or more embodiments, the foot data may be stored in a record. This record may include information regarding the person whose foot created the imprint. In one embodiment, foot imprint data may be obtained at differing times and then be compared to provide information 15 regarding how the shape and size of the person's foot is changing over time.

The invention has a number of advantages. First, the invention comprises a user-friendly system which permits accurate determination of the size and shape of a foot. The invention includes 20 a system and method for displaying the measurements on a screen and also creating and storing a the record pertaining to the person from whom the images of the feet were obtained. Hardware and software may be provided for automatically measuring the shape and size, including curvature, of the feet and may be used to estimate any changes in foot measurements since a previous

measurement, thereby providing correction data needed to manufacture the orthotic shoes, or sole inserts.

In accordance with the invention, unique characteristics of a person's foot may be identified.

5 For example, the method can be used to identify corns and callouses on a person's feet. Using the foot data which includes data of such features, the shoe, orthotic or the like can be customized to compensate for such features.

The method and apparatus provides a means for accurately determining the shape and size of a foot. This makes it possible to detect small changes in the shape or size of a foot, such as may be necessary to identify whether a particular corrective orthotic is having a beneficial effect upon the foot over time.

It will be understood that the above described arrangements of apparatus and the method therefrom are merely illustrative of applications of the principles of this invention and many other embodiments and modifications may be made without departing from the spirit and scope of the invention as defined in the claims.

CLAIMS OF THE INVENTION

I CLAIM:

1. A method of determining the shape and size of a foot comprising the steps of:
  - obtaining an imprint of the foot;
  - scanning the imprint of the foot to obtain pixel image data regarding the foot imprint at one or more points;
  - determining at said one or more points the depth of the imprint from the image data;
  - determining the size of said foot imprint; and
  - determining the curvature of one or more portions of said foot imprint.

2. The method in accordance with Claim 1 including the step of obtaining red, blue and green pixel image data of the foot imprint at one or more points.
3. The method in accordance with Claim 1 including the step of converting said red, blue and green pixel image data to YIQ pixel data.
4. The method in accordance with Claim 3 wherein said step of determining the depth comprises determining the depth of the imprint at a point from the Y pixel data for that point.
5. The method in accordance with Claim 1 including the step of generating an altered image of said foot imprint and determining the size of said foot imprint from said altered image.

6. The method in accordance with Claim 5 including the step of passing image data through a filter to create said altered image.

7. The method in accordance with Claim 1 including the step of generating an element  
5 for mating with at least a portion of the foot using said depth, size and curvature information.

8. The method in accordance with Claim 1 including the step of storing said depth, size and curvature information.

9. A method of determining the size and shape of a foot comprising:  
10 obtaining image data of an imprint of the foot at one or more points, said image data including a luminesce value;  
determining a depth of the imprint at one or more points with said luminance value said one or more points and a slope of the luminesce value at said one or more points.

10. The method in accordance with Claim 9 wherein a depth value is determined at one or more points in accordance with a linear function of the luminance value and luminance value slope said one or more points.

20 11. The method in accordance with Claim 9 wherein said luminance value and luminance value slope are modified by a first and a second coefficient, respectively.

12. The method in accordance with Claim 11 wherein a value of said first and second coefficients is determined using a least square method to minimize the average error.

13. The method in accordance with Claim 11 wherein a value of said first and second  
5 coefficients is determined by measurement.

14. A method of determining the shape and size of a foot comprising the steps of:  
obtaining an imprint of the foot;  
scanning the imprint of the foot to obtain pixel image data regarding the foot imprint at one  
10 or more points;  
determining at said one or more points the depth of the imprint from the image data; and  
determining a size of said foot from said pixel image data.

15. The method in accordance with Claim 14 wherein the step of obtaining an imprint comprises creating an imprint in a foam member.

16. The method in accordance with Claim 14 wherein the step of scanning comprises  
obtaining RGB pixel image data.

20 17. The method in accordance with Claim 16 including the step of converting said RGB  
pixel image data to YIQ pixel image data and determining said depth using said YIQ data.

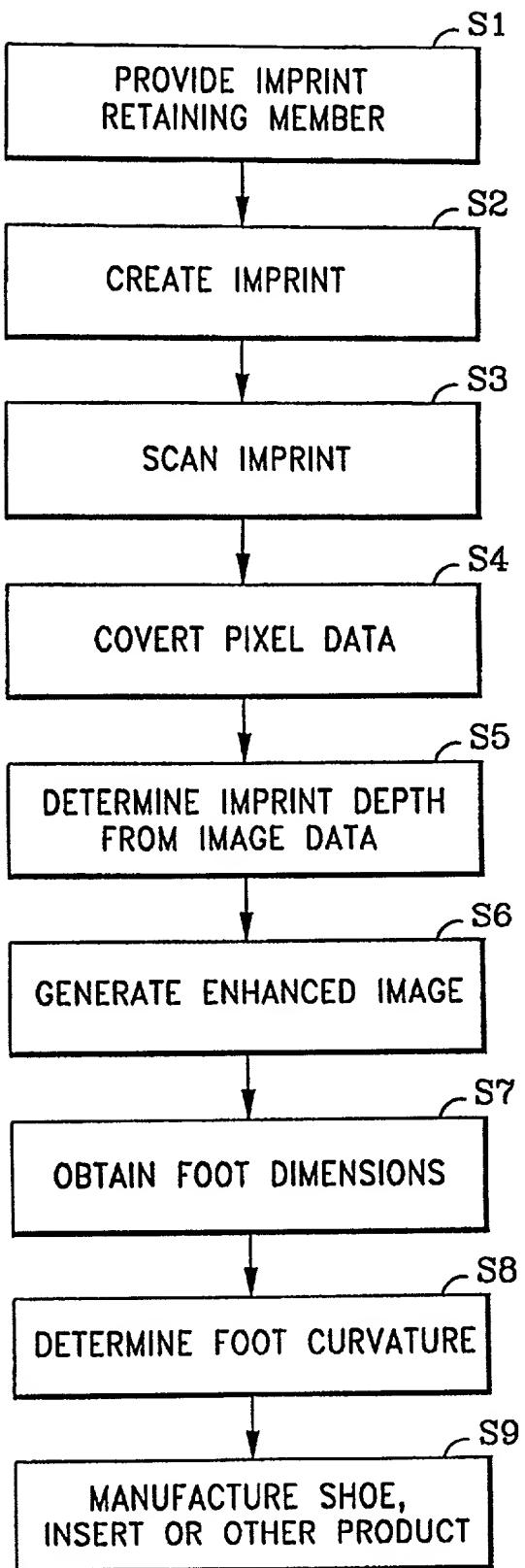
18. The method in accordance with Claim 16 including determining the curvature of said foot in one or more areas using said pixel image data.

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**METHOD AND APPARATUS FOR FOOT  
IMPRINT SCANNING FOR ORTHOTICS**  
**ABSTRACT OF THE INVENTION**

A method and apparatus for determining the shape and dimension of a human foot is disclosed. One embodiment of a method comprises the steps of obtaining an imprint of the foot, scanning the imprint of the foot to obtain pixel image data regarding the foot imprint at one or more points, determining at said one or more points the depth of the imprint from the pixel image data, and determining a size of said foot from the pixel image data. In one embodiment, an imprint is created by a person stepping onto a foam member. In one embodiment, the scanning step generates RGB pixel data and this data is converted to YIQ data. The depth of the imprint is generated using the Y or luminance value information for a point. In one embodiment, foot size information is determined from the scanned foot imprint. The foot size and shape data may be used to create an orthotic, shoe, sandal or the like.

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*FIG. 1*

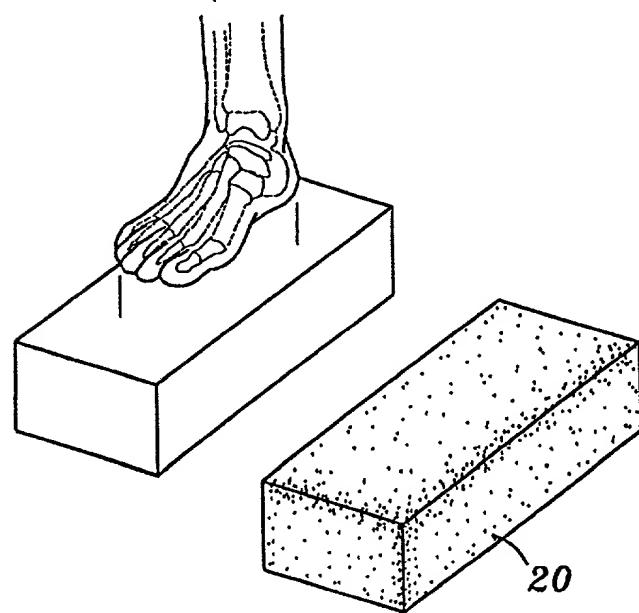
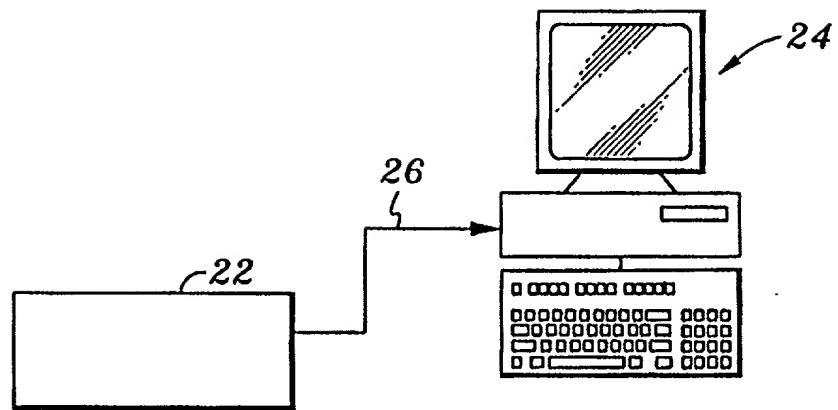


FIG. 2

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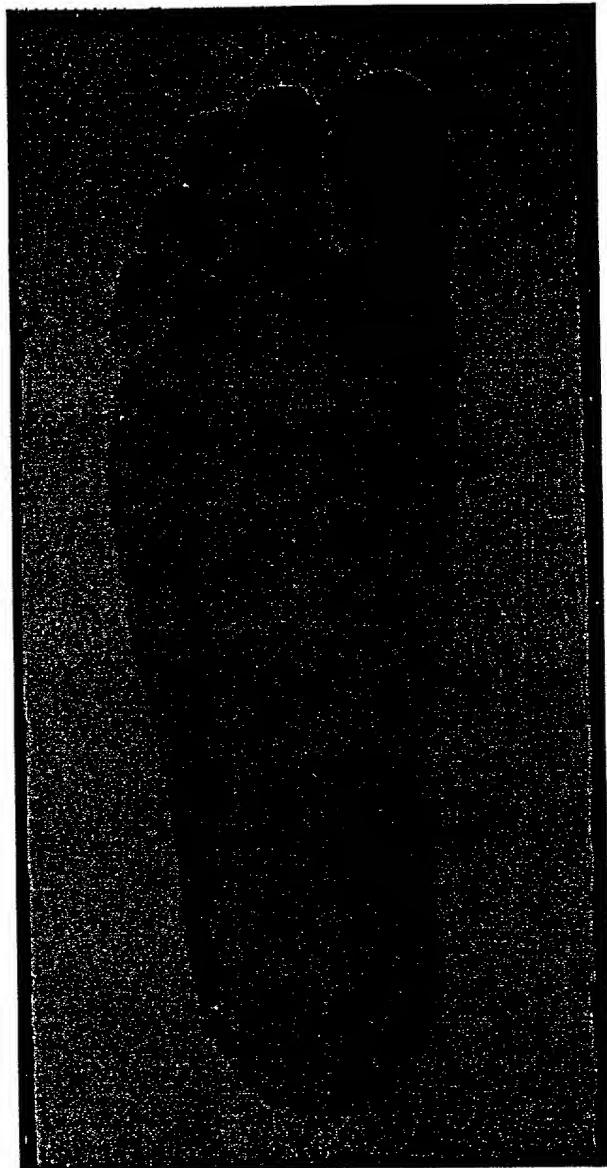


Figure 3

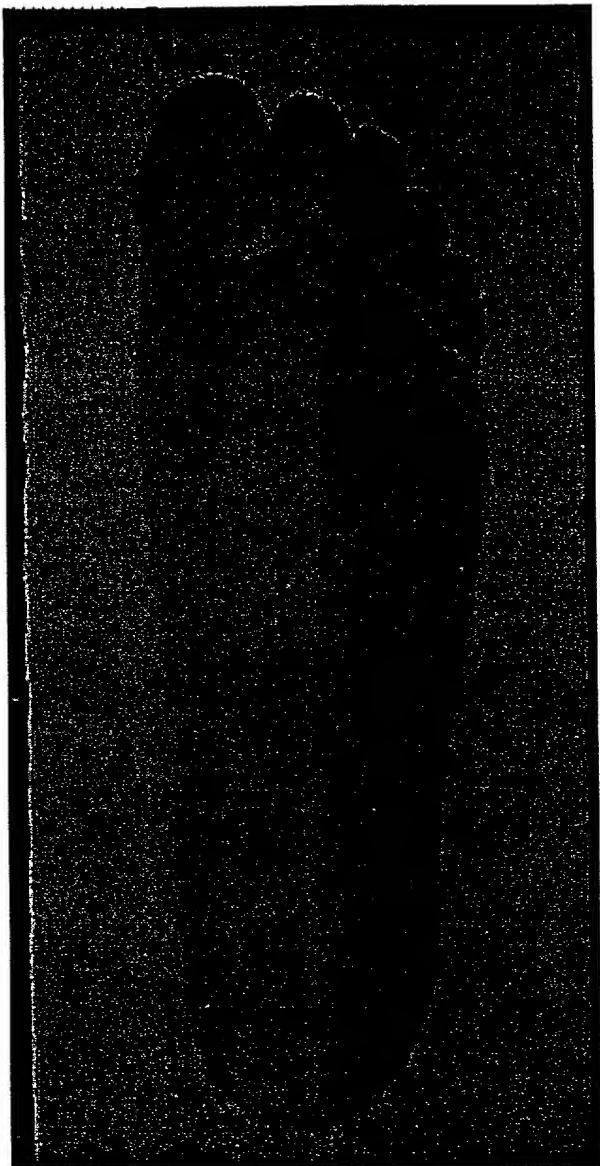


Figure 4

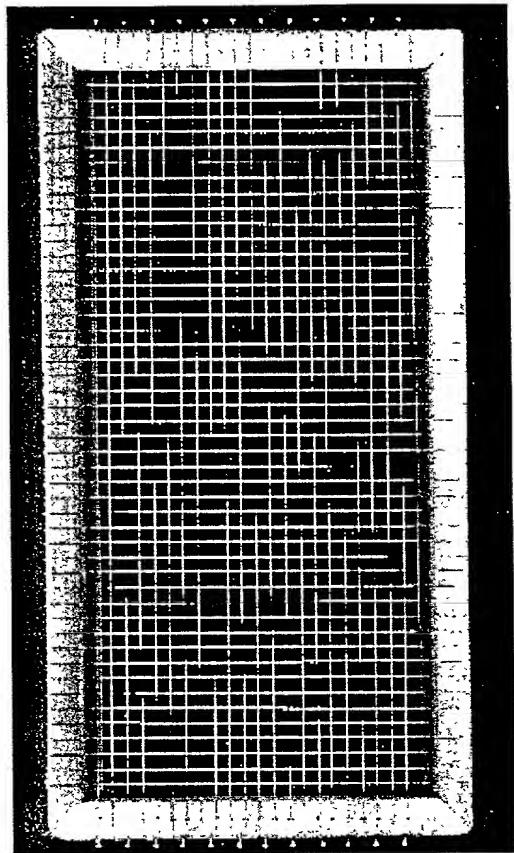


Figure 5

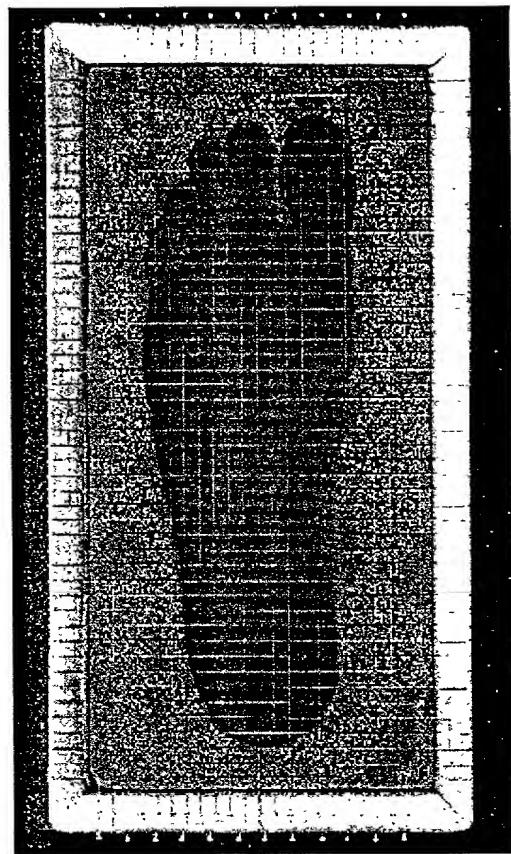


Figure 6

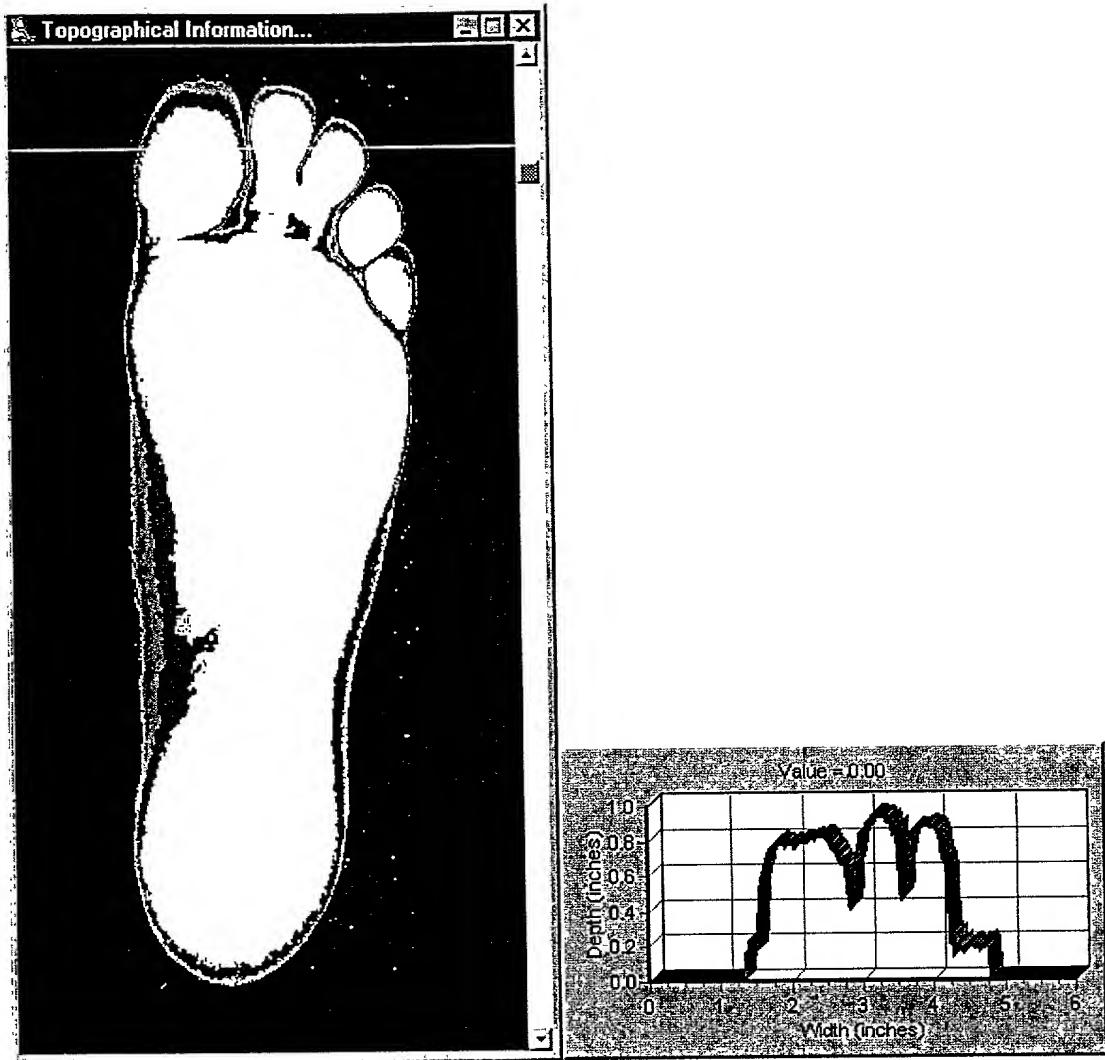


Figure 7

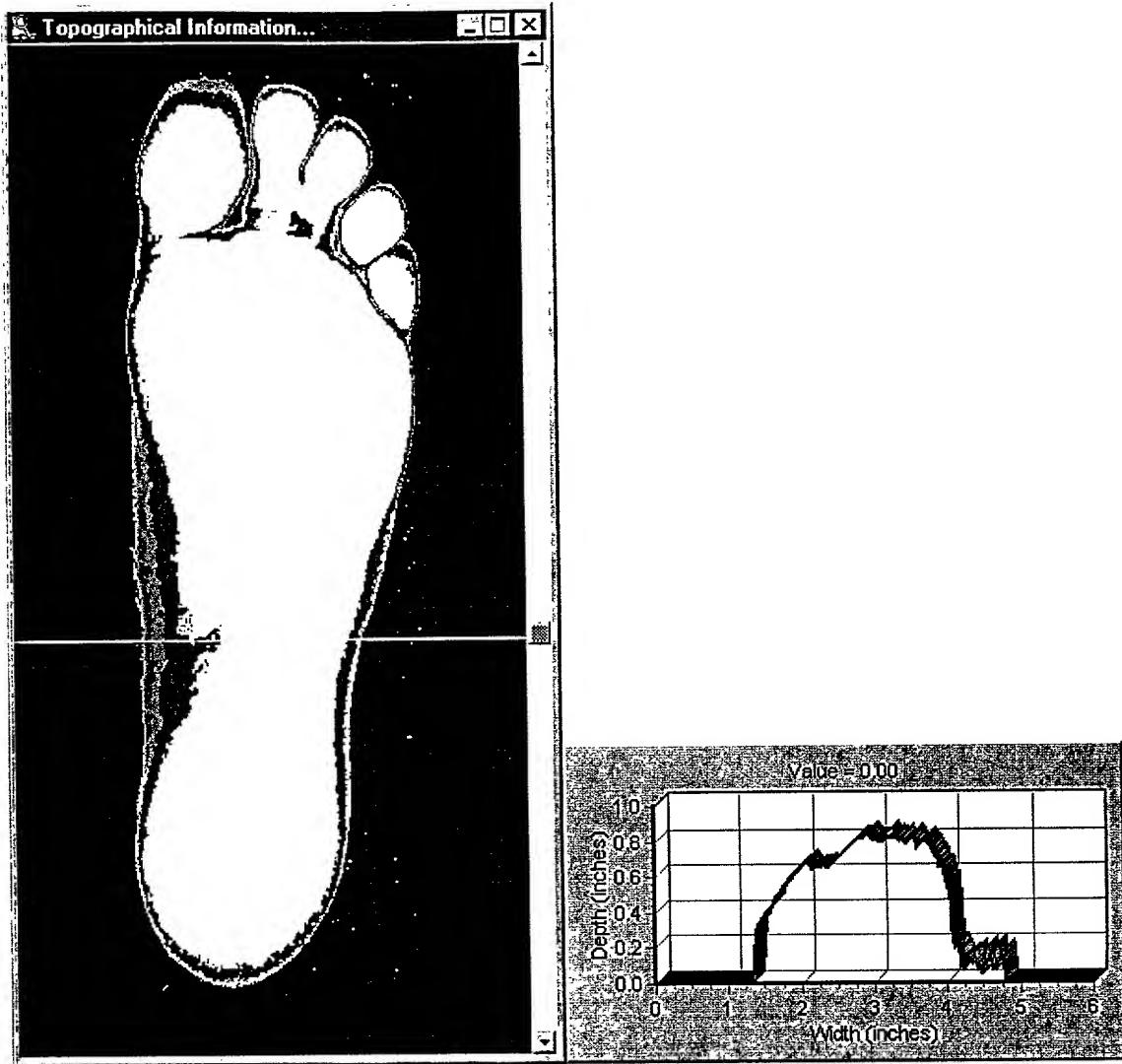


Figure 8

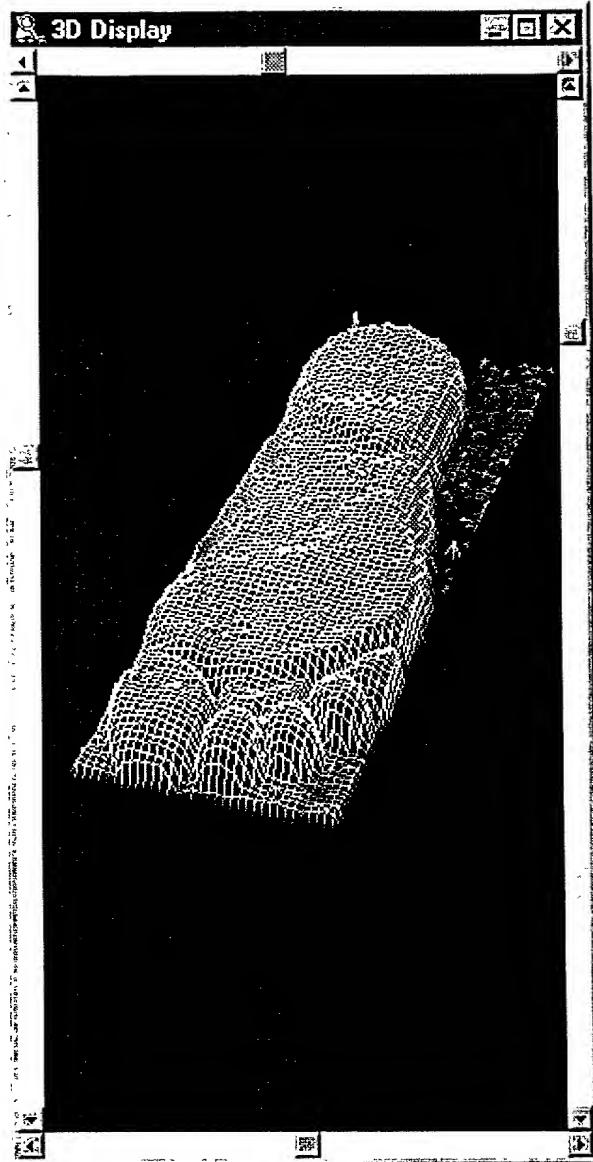


Figure 9

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28

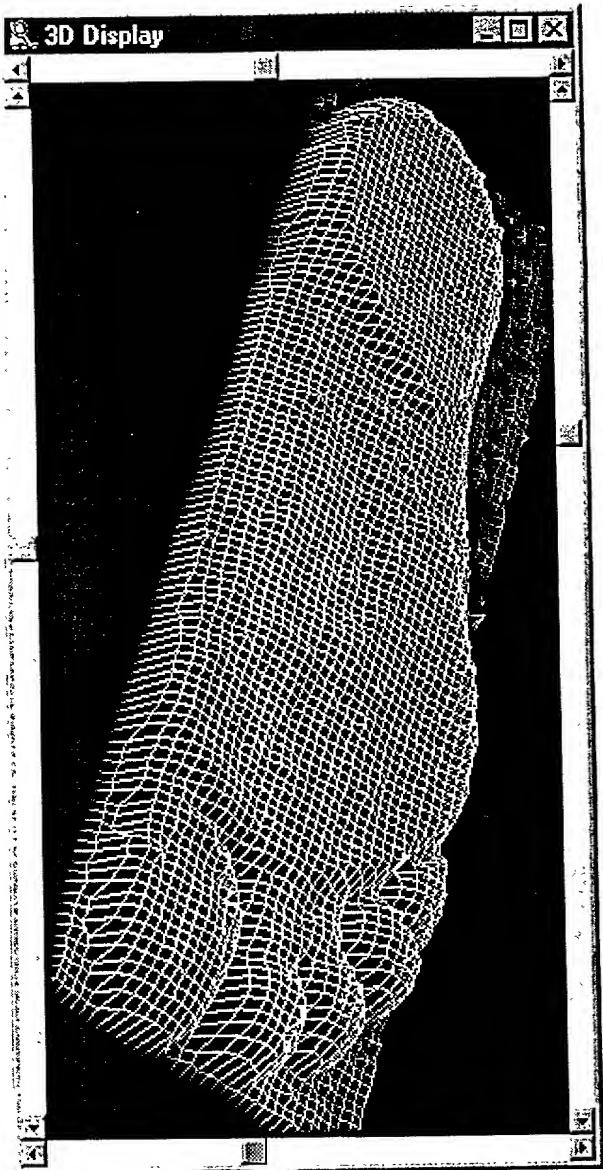


Figure 10

**DECLARATION AND POWER OF ATTORNEY - USA PATENT APPLICATION**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled METHOD AND APPARATUS FOR DETERMINING THE SIZE AND SHAPE OF A FOOT; the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above;

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56;

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States of PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56, which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S. Application(s)

None.

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

Prior U.S. Provisional Application(s)

None.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate or PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

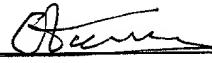
None.

POWER OF ATTORNEY: I hereby appoint R. Scott Weide, Registration No. 37,755, of Weide & Associates, Ltd., 330 S. 3<sup>rd</sup> Street, Suite 1130, Las Vegas, NV 89101, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith (if this application is assigned, I acknowledge that the appointed individual does not represent me but instead represents the assignee).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful, false statements may jeopardize the validity of the application or any patent issued thereon.

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Full name of sole inventor: **Evangelos A. Yfantis**

Inventor's signature 

Date OCT. 6, 2000

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